JAPAN

EDICT OF GOVERNMENT

JIS B 9923 (1997) (English): Clean room garment -- Methods for sizing and counting particle contaminants in and on clean room garments

安 倂

The citizens of a nation must honor the laws of the land.

Fukuzawa Yukichi

BLANK PAGE

BLANK PAGE

JIS

JAPANESE
INDUSTRIAL
STANDARD

Translated and Published by
Japanese Standards Association

JIS B 9923 : 1997

Clean room garment - Methods for sizing and counting particle contaminants in and on clean room garments

ICS 19.120

Descriptors : clean rooms, clothing, uniforms, contaminants, particle size measurement, particulate air pollutants

Reference number : **JIS B 9923 : 1997 (E)**

Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of International Trade and Industry through deliberations at Japanese Industrial Standards Committee in accordance with the Industrial Standardization Law. Consequently, JIS B 9923: 1986 has been revised and replaced with this Standard.

Date of Establishment: 1986-11-01

Date of Revision: 1997-09-20

Date of Public Notice in Official Gazette: 1997-09-22

Investigated by: Japanese Industrial Standards Committee

Divisional Council on General Machinery

JIS B 9923 : 1997, First English edition published in 1998-02

Translated and published by: Japanese Standards Association
4-1-24, Akasaka, Minato-ku, Tokyo, 107-8440 JAPAN

In the event of any doubts arising as to the contents, the original JIS is to be the final authority.

Clean room garment – Methods for sizing and counting particle contaminants in and on clean room garments

1 Scope This Japanese Industrial Standard specifies the measuring methods for particles having diameter of 5 μm or over to and smaller than 50 μm, and of 50 μm or larger, and fibers 100 μm or larger in length, and for the number of separable particles having diameters of 0.5 μm or larger, 1 μm or larger, and 5 μm or larger attached in and on the stuff of clean room garments (1) made of cloth used in clean rooms (hereafer referred to as "clean garments").

Note (1) The clean room garments mean working clothes for use in clean rooms comprising a continuous garments, a set of upper and lower garments, and a coat.

Remarks 1 The normative references to this Standard are as follows.

JIS B 8330 *Testing methods for turbo-fans blowers*

JIS B 9921 *Light scattering automatic particle counter*

JIS K 8593 *Petroleum ether*

JIS K 8839 *2-Propanol*

JIS K 8848 *Hexane*

JIS P 0138 *Trimmed sizes of paper*

JIS Z 8122 *Contamination control – Vocabulary*

2 The units and numerical values given in { } in this Standard are based on the traditional units and are appended for informative reference.

2 Definitions The definitions of the main terms used in this Standard are as specified in **JIS Z 8122**.

3 Measuring environment The measuring environment for particles attached to clean garments shall have a cleanness equivalent or superior to that of the clean room in which the clean garment is used.

4 Kind of measuring methods The measuring methods shall be classified into the following two methods:

(1) **Microscopic method** This method is performed as follows: Pass sufficiently clean air for 1 min at a rate of 14×10^{-3} m^3 (14 *l*) per minute through an area of 0.960×10^{-3} m^2 (960 mm^2) for each position of each sheet of the garment stuff at six specified positions of the garments. Then filter with a measuring membrane filter the air which has passed through the working garment and contains particles separable from the clean garment and collect the particles exfoliated from the garment on the filter surface, and count by a microscope the number of particles of 5 μm or over to and smaller than 50 μm and 50 μm or larger and the number of fibers of 100 μm or larger in length.

(2) **Light scattering automatic particle counting method** This method is performed as follows: Move a part or the whole of the clean garment under prescribed conditions in a definite clean environment and thereby produce floating dust and measure the cleanness of the supplied air and discharged air by the counter specified in **JIS B 9921**. Thus, find the number of particles per unit volume of the particles exfoliated from the clean garment for respective particle diameter divisions of 0.5 μm or larger, 1 μm or larger, and 5 μm or larger from the change in concentration and the quantity of discharged air.

Remarks: The counter used for measuring the particle concentration of the supplied air and discharged air shall be the same one.

5 Microscopic method

5.1 Appliances used for measurement The following appliances shall be used for measurement.

(1) **Measuring membrane filter** The measuring membrane filter used for collecting the particles and fibers exfoliated from the clean garment shall have a diameter of 47 mm, apertures of within 0.8 μm and a printed lattice consisting of 3.1 mm squares, and be black in colour.

(2) **Filter holder with adapter** The filter holder with adapter shall consist of a set of filter holders in which a sheet of the stuff of the specimen clean garment can be fitted and conically clamped between a prefilter holder with a conical inner surface capable of accommodating an air filter and a filter holder with a conical outer surface for accommodating the measuring membrane filter, and there shall be no air leakage in the condition of the two filter holders being fastened together.

The effective filtering area on the measuring membrane filter shall be 929×10^{-3} m^2 (929 mm^2).

(3) **Tweezers** The tweezers shall have a flat end free from the danger of cutting the filter.

(4) **Petri dish or slide glass** The petri dish or slide glasses used shall be capable of keeping the measuring membrane filter in a clean condition.

(5) **Suction pump** The suction pump shall have a sucking capacity of 14×10^{-3} m^{-3} (14 *l*) per minute in the condition in which the stuff of the clean garment, measuring membrane filter, and critical orifice or flowmeter are attached.

Informative reference : A vacuum pump having a sucking capacity of 67 kPa {500 mm Hg} or larger may be used.

(6) **Microscope** The microscope shall have a resolving power sufficient for measuring the minimum particle diameter of 5 μm, have a flat visual field, and meet the following requirements of (**a**) to (**e**).

(a) The combined magnification of the microscope shall be 50± 10 and 100± 10, and the magnification of the eyepiece shall be 10 and that of the objective shall be 5 and 10.

(b) A biocular or monocular microscope shall be used, but a stereo-microscope shall not be used.

(c) The moving stage shall be capable of scanning the whole effective filtering area of the measuring membrane filter.

(d) The eyepiece micrometer shall have a scale of 10 mm length divided into 100 parts.

(e) The illuminator shall be able to illuminate from oblique directions, to change the brightness, to adjust the focus of the condenser lens, and in addition, to change the direction freely.

(7) **Counter** The counter shall be able to count the number of particles by manual operation.

(8) **Stage micrometer** The stage micrometer shall have a scale dividing a length of 1 mm into 100 parts.

5.2 Reagents The reagents shall be used after being filtered with a membrane filter with 0.45 μm apertures, and consist of the following:

Distilled water

Isopropyl alcohol The isopropyl alcohol used shall conform to Grade 1 of **JIS K 8839**.

Petroleum ether The petroleum ether used shall conform to guaranteed grade of **JIS K 8593**.

Remarks: As a substitute for petroleum ether, the guaranteed grade hexane of **JIS K 8848** may be used.

5.3 Measuring procedures

5.3.1 Verification and background measurement The verification and background measurement shall be performed as follows:

(1) **Verification of eyepiece micrometer** Place the stage micrometer on the moving stage and make verification by examining, based on the stage micrometer, the number of micrometers to which the scale mark of the eyepiece micrometer corresponds, with respect to magnification of 50 and 100.

Remarks: The verification of the eyepiece micrometer shall be made cover its entire scale and not be limited to its portions.

(2) **Background measurement** Measure the background according to the procedures of **5.3.2** to **5.3.5** without attaching the clean garment to the filter holder with adapter. Repeat this operation two times and take the average of the measured values as the background.

5.3.2 Preparatory operation The preparatory operation shall be performed as follows:

(1) In the measurement of particles attached to the clean garment, the measurer shall wear a

garment for clean room properly by a method to prevent contact with the floor or other furniture.

(2) Preliminarily clean the filter holder with adapter, tweezers, filter supporting base, and slide glasses at each measurement according to the following order:

(a) Remove oil by rinsing with petroleum ether.

(b) Thoroughly wash in warm water using a neutral detergent and then rinse with warm water two times.

(c) Rinse with filtered, distilled water two times.

(d) Remove water by rinsing with filtered isopropyl alcohol. Further, after rinsing with filtered petroleum ether, evaporate.

(3) Take a sheet of measuring membrane filter out of the container using tweezers and rinse both surfaces with filtered petroleum ether.

(4) Place the measuring membrane filter with its latticed surface upward on the filter supporting base and attach to the filter holder.

(5) Connect the filter holder and the critical orifice or flowmeter to the suction pump by using a hose.

(6) Where the specimen clean garment is packaged, take it out by cutting the package with a sharp cutting tool. In this case, never tear the package.

(7) Hang the specimen clean garment with a clean hanger or the like at a position facilitating the collection of particles for measurement in a clean environment to prevent contamination during the collection of particles.

5.3.3 Collection of particles The collection of separable particles attached to the clean garment shall be performed as follows:

(1) The positions for collecting particles separable from the clean garment shall be the 6 positions shown in Fig. 1.

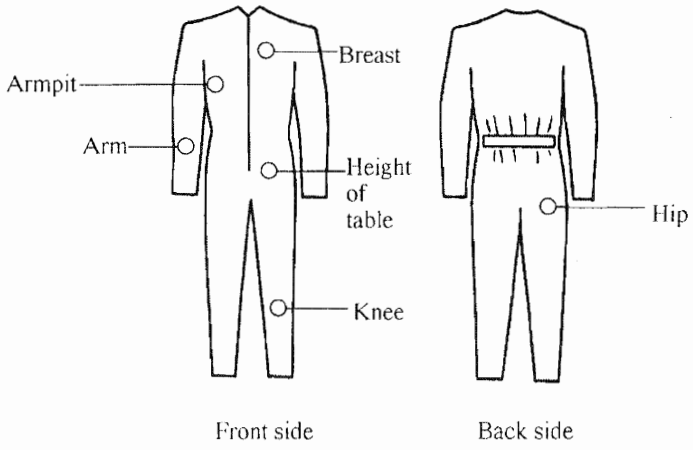

Fig. 1 Positions for collecting particles

(2) At the respective collecting positions on the specimen clean garment, apply the outer surface of the filter holder attached with a measuring membrane filter (refer to Fig. 2) to the outer surface of the specimen clean garment.

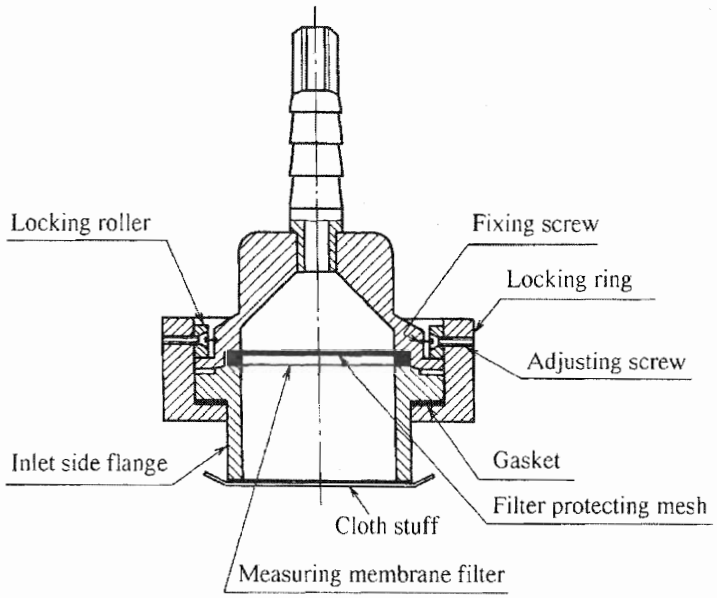

Fig. 2 Filter holder

(3) The quantity of sucked air shall be the air quantity sucked in 1 min at a flow rate of 14 $\times 10^{-3}$ m ^{3} per minute at each particle collecting position.

Remarks: Where a flowmeter is used between the filter holder and the vacuum source, the actual flow rate at the standard temperature and the standard pressure shall be determined by carrying out corrections for temperature and pressure.

In this case, the standard temperature shall be at 20 ℃ and the standard pressure at 101.325 kPa {1 atm.}.

5.3.4 Preservation of measuring membrane filter The measuring membrane filter on which the particles and fibers exfoliated from the clean garment have been collected shall be detached from the filter holder by using tweezers and kept held between clean slide glasses or placed in a petri dish for use as the microscope specimen.

5.3.5 Measurement Measurement shall be carried out according to the following procedures:

(1) Place the measuring membrane filter carrying out collecting particles and fibrous particles (hereafter referred to as "sample") on the stage of the microscope. In this operation, make the lines of the lattice on the sample agree with the coordinate axes of the moving stage. Where the sample is preserved in a Petri dish, make measurement by detaching the cover as required.

(2) Scan over the sample surface at a low magnification and confirm that the particles are dispersed uniformly.

(3) The magnification of the microscope shall be 100 for particles of 5 μm or over to and smaller than 50 μm and be 50 for particles of 50 μm or larger and fibers.

(4) The particle diameter divisions shall consist of particles of 5 μm or over to and smaller than 50 μm, particles of 50 μm or larger, and fibrous particles of 100 μm or larger in length.

(5) Measure the passing particles by the scale of the eyepiece micrometer while shifting the microscope stage. If the direction of the largest diameter of a particle is inclined against the scale line, estimate the largest diameter. In this case, it is unnecessary to measure the diameter by rotating the eyepiece micrometer.

(6) Where it is estimated that the number of particles of the objective particle diameter division is 1 to 500 in the effective filtering area, count the number of particles present in the whole effective filter area.

(7) Where it is estimated that the number of particles of the objective particle diameter division is 500 to 1 000 in the effective filtering area, count the particles present in arbitrarily chosen 20 grids (refer to Fig. 3).

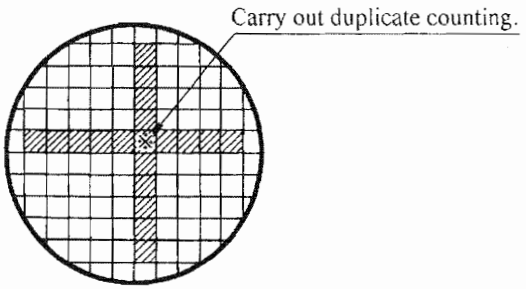

Fig. 3 Counting method

(8) Where the number of particles of the objective particle diameter division is estimated to be 1 000 to 5 000 in the effective filtering area, count the particles present in arbitrarily chosen 10 grids.

(9) Where the number of particles of the objective particle diameter division is estimated to exceed 5 000 in the effective filtering area, count, for the respective particle diameter divisions, the number of particles in a definite area in each of arbitrarily chosen 10 grids (refer to Fig. 4). In this case, select either of the following (**a**) or (**b**) as the definite area in a grid so as to make the number of particles present therein about 50.

(a) An area of which the longitudinal length agrees with the entire scale of the eyepiece micrometer and the lateral length agrees with the entire width of the grid.

(b) An area of which the longitudinal length covers a part of the eyepiece micrometer and the lateral length agrees with the entire width of the grid.

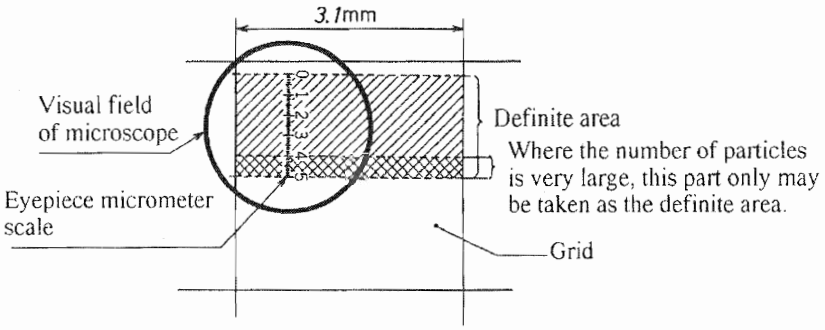

Fig. 4 Method of selecting definite area in a grid

(10) Where a particle lies on the upper or left side boundary line of a grid, count this particle as one, and where it lies on the lower or right side boundary line, do not count this particle.

5.3.6 Apparent total number of particles and number of separable particles at collecting position The methods for obtaining the apparent total number of particles at one collecting position and the number of particles separable from unit area of the clean garment shall be in accordance with the following (**1**) and (**2**).

(1) The apparent total number of particles in the cases of (**7**), (**8**) and (**9**) of **5.3.5** shall be obtained from the following formula:

$$P_t = \frac{A}{F_n \times F_a} \times N_t$$

where, P_t: apparent total number of particles of objective particle diameter division (pieces/960 mm^2)

A: effective filtering area (960 mm^2)

F_n: number of grids selected (grids)

F_a: area of grid or selected definite area in a grid (mm^2/grid)

N_t: sum of numbers of particles measured in selected definite areas in F_n units of grid (pieces)

(2) The number of particles P_i (pieces/m^2) at a certain collecting position i among the specified 6 positions of the garment shall be obtained from the following formula:

$$P_i = \frac{P_t - P_b}{960} \times 10^6$$

where, P_i: number of separable particles of the objective particle diameter division at collecting position i (pieces/m^2)

P_t: apparent total number of particles of the objective particle diameter division (pieces/960 mm^2)

P_b: apparent total number of particles in background (pieces)

5.3.7 Cleanness of clean garment The cleanness of the clean garment shall be expressed by the average of the values of P_i at the 6 collecting positions in Fig. 1.

5.4 Indication of results of measurement The results of measurement shall be indicated as shown in the rightmost column of Table 1 for the respective particle diameter divisions.

Table 1 Recording form for results of measurement by microscopic method (example)

No.	Date of measurement	Place of measurement	Temperature (℃)	Humidity (%)	Atmospheric pressure (kPa)	Nominal hole diameter of membrane filter used	Name of measurer

Particle diameter division	Collecting position	Number of particles in whole area, in grids, or in definite areas (pieces)	Number of measured grids (units)	Total number of measured grids (units)	Total number of particles in effective filtering area (pieces)	Background (pieces)	True number of particles (pieces)	Number of particles per m^2 per suit of garment (pieces)
Particle of 5 μm or over to and smaller than 50 μm	1							
	2							
	3							
	4							
	5							
	6							
Particle of 50 μm or larger	1							
	2							
	3							
	4							
	5							
	6							
Fibrous particles	1							
	2							
	3							
	4							
	5							
	6							

6 Light scattering automatic particle counter method

6.1 Measuring apparatus The measuring apparatus is a device for obtaining the relative cleanness of clean garments by moving a part or the whole of the garment for a definite time under given conditions , as shown in Fig. 5, in an environment free from air leakage in which a definite quantity of clean air is supplied from one side of the device and is discharged from the other side, and while the environment is being contaminated with separable particles exfoliated from the clean garment, measuring the particle concentrations of the supplied air and discharged air and the air flow rate.

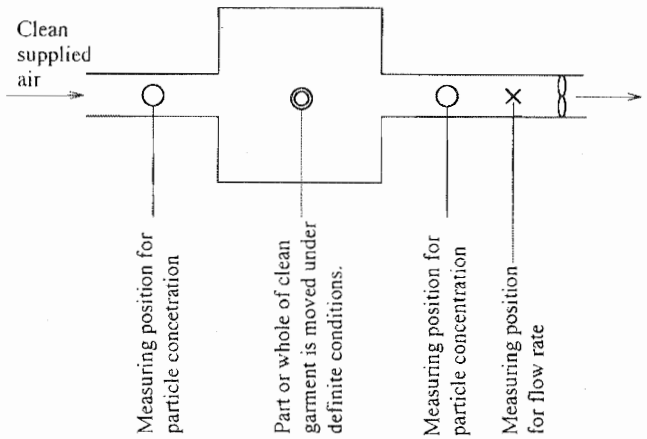

Fig. 5 Principle of measuring apparatus

6.2 Appliances used for measurement The appliances used for measurement shall meet the following requirements:

(1) **Dust generating device** The dust generating device shall be able to move a part or the whole of the clean garment under given conditions and exfoliate separable particles from the surface and the inside of the clean garment by a reproducible method. Dust generating devices include those by the shaking method and tumbling method as shown in the following:

(1.1) **Shaking method** The dust generating device by the shaking method is one which generates dust by giving up and down and rotary motions to a set of upper and lower holders between which the specimen clean garment is attached, as shown in Fig. 6, and shall meet the following requirements (**a**) to (**e**):

(a) The upper and lower holders shall be as shown in Fig. 7 and be capable of being fitted with specimen stuff of A 4 size and A 3 size specified in **JIS P 0138**.

(b) They shall be able to perform continuously the up and down motion and rotating motion of holders independently or simultaneously.

(c) The stroke of the up and down motion shall be 10 cm or larger and the angle of the rotary motion shall be ± 270 or larger, and the time of one reciprocation shall be within 3 s.

(d) The box (555 mm in depth, 555 mm in breadth, and 520 mm in height) covering the holder unit shall be treated for electric charge prevention.

(e) Dust generation from the driving unit shall be prevented.

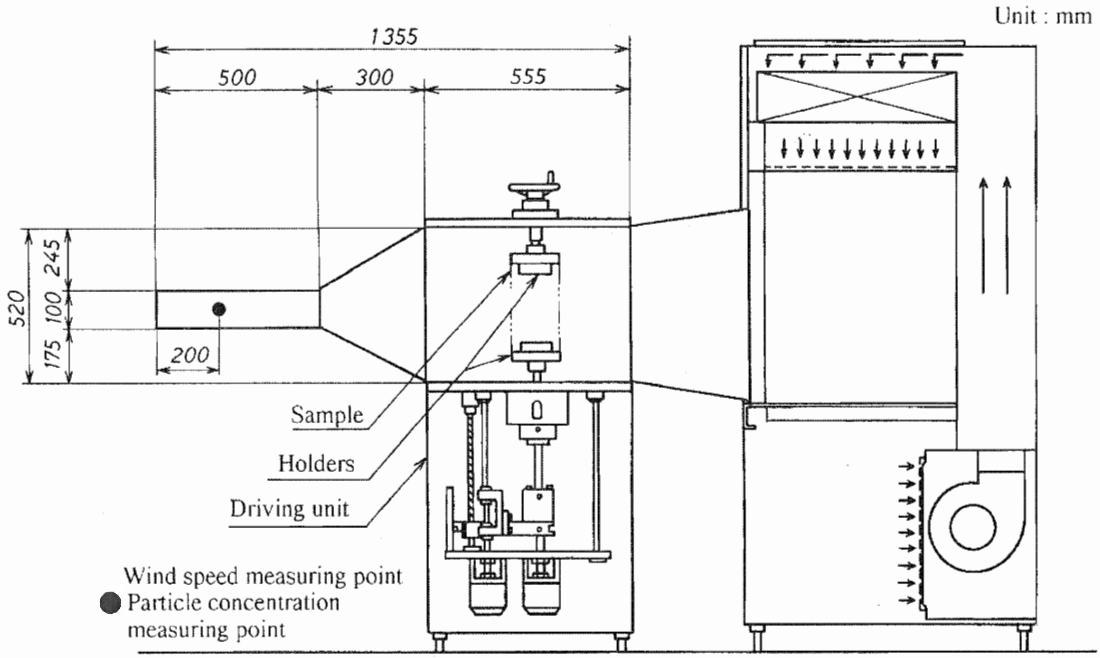

Fig. 6 Dust generating device (shaking method)

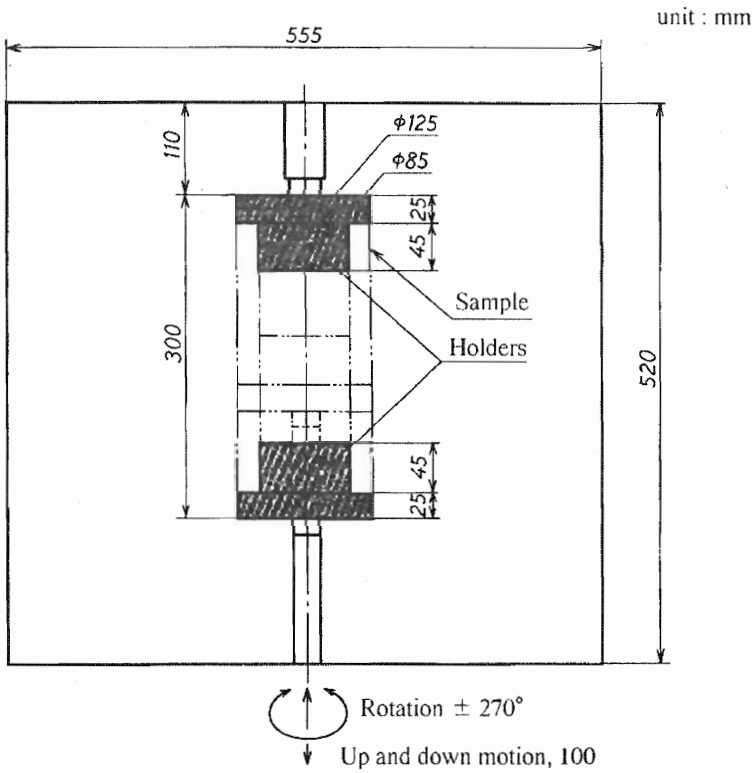

Fig. 7 Holder part

(1.2) **Tumbling method** The dust generating device by the tumbling method is one in which the specimen clean garment or cloth (material of garments) is placed in a drum and dust is generated by rotating the drum, as shown in Fig. 8, and shall meet the following requirements (**a**) and (**b**):

(a) The drum shall be capable of supplying clean air during its rotation and have an opening for discharge of air.

(b) The drum shall have a cross-section as shown in Fig. 9 and rotate at a rotating speed of 30 r.p.m. to 50 r.p.m.

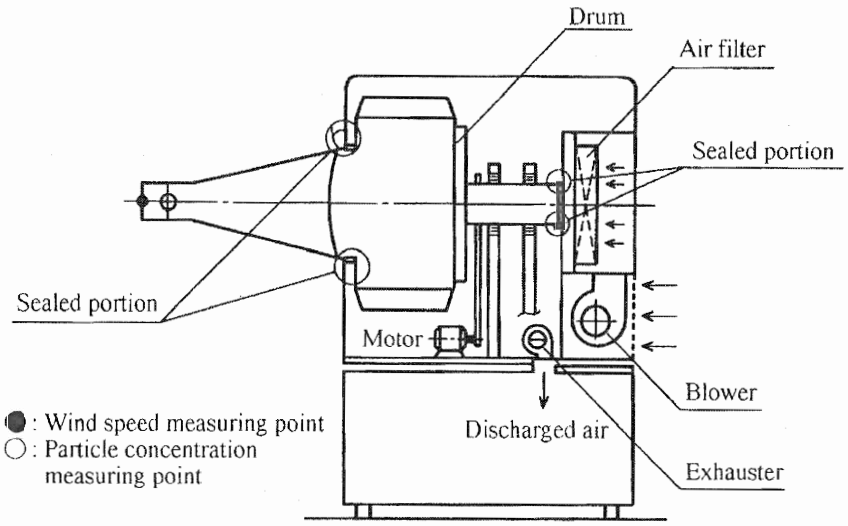

Fig. 8 Dust generating device (tumbling method)

Unit : mm

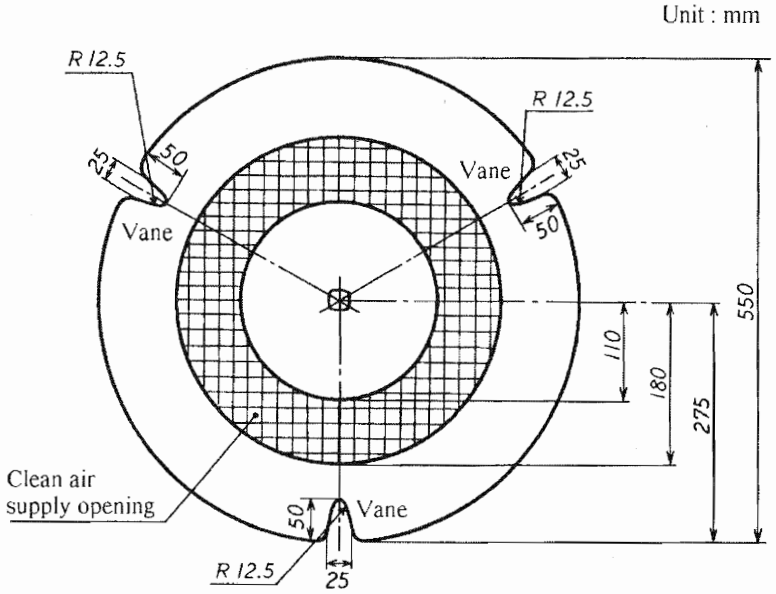

Fig. 9 Cross-section of drum

(2) **Light scattering automatic particle counter** The light scattering automatic particle counter used shall conform to **JIS B 9921** and be able to count the number of particles having diameters of 0.5 μm or larger, 1 μm or larger, and 5 μm or larger, respectively.

6.3 Reagents The reagents used shall have a quality equal or superior to that specified in **5.2**.

6.4 Measuring procedures

6.4.1 Preparatory operation The preparatory operation shall be performed as in **5.3.2** (**1**) and (**2**), as appropriate.

6.4.2 Adjustment of light scattering automatic particle counter The light scattering automatic particle counter shall be adjusted according to the following order:

(1) **Preheating** Before using the counter, set the power supply switch at "on" or "stand-by" and let it stand for 20 min to 60 min to stabilize the device.

(2) **Adjustment by internal standard light** Set the particle diameter division selector switch or calibration switch and the like at the prescribed positions and adjust the device in the condition of the internal standard light emitting unit being operated.

(3) **Suction of air** Locate the air sucking mouth or the opening of the suction tube, connected to the air sucking mouth at a shortest possible distance, at the measuring position for particle concentration shown in Fig. 5, and adjust the suction flow rate of the light scattering automatic particle counter.

6.4.3 Background The background shall be determined by measuring the particle concentrations of the supplied air and discharged air by a light scattering automatic particle counter according to the procedure of **6.4.4**, as appropriate, while supplying clean air to the measuring apparatus shown in Fig. 5 without attaching the clean garment to the particle generating device.

The flow rate shall be measured according to **JIS B 8330**.

The apparent number of particles of the background shall be obtained from the following formula:

$$P_{Bt} = Q_B \times (C_{B1} - C_{B2})$$

where, P_{Bt}: total number of particles of background (pieces/s)

Q_B: flow rate of discharged air (m^3/s)

C_{B1}: particle concentration of discharged air (pieces/m^3)

C_{B2}: particle concentration of supplied air (pieces/m^3)

6.4.4 Measurement The separable particles attached to the clean garment shall be measured as follows:

(1) The mode of motion as the prescribed condition for exfoliating separable particles from the clean garment or cloth (material of garments) shall consist of the three motions—up and down, rotation, and combination of up and down and rotation—in the case of the shaking method, and consist of the rotary motion in the case of the tumbling method, and the type of apparatus, manner of its use, and the measuring time shall be clearly described in the report.

Remarks: Although in the shaking method, it is desirable to make measurement for the three kinds of motion, these motions may be represented by one kind of motion. The time duration of the motion shall be 60 min.

(2) Supply clean air to the measuring apparatus and measure the flow rate according to **JIS B 8330**.

(3) Measure the particle concentration of supplied air by a light scattering automatic particle counter and record it.

(4) Attach specimen clean garment or cloth (material of garments) to the dust generating device. When measuring the cloth (material of garments) in tumbling method, two samples of 1 m square shall be used.

(a) The device shall be set in clean environment.

(b) Sufficiently low level particle concentrations during device operation, that is, the particles of 0.5 μm or larger are 0 piece/m^3 or those reach the level of 10 pieces/m^3, shall be taken as background concentrations.

(c) After obtaining of the background concentrations for said device, measurer shall put on a pair of clean gloves to his/her both hands and immediately take out the specimen clean garment from the package according to the procedure specified in **5.3.2 (6)** in the clean environment, then throw it into the rotating tumbling chamber and attach it to the device.

(d) Start the measurement after 30 s from completing of procedure of (**c**) above-mentioned.

(5) Move the whole of specimen clean garment or cloth (material of garments) under the prescribed conditions and measure the particle concentration of discharged air by the same light scattering automatic particle counter as used in (**3**) and record it.

(6) The specimen subjected to measurement shall be cloth for one suit (two sheets of cloth of 1 m square) or one suit in the case of tumbling method and one sheet of cloth of 1 m square in the case of shaking method, and measurement shall be carried out 5 or more times for 5 min or over, and the measured particle concentration during the motion shall be determined from the values of specimens excluding those of the largest and smallest values.

6.4.5 Methods of obtaining apparent number of particles and number of separable particles Apparent number of particles and number of separable particles shall be obtained as follows.

(1) The apparent number of particles shall be obtained from the following formula:

$$P_t = Q \times (C_1 - C_2)$$

where, P_t: apparent total number of particles of objective particle diameter (pieces/s)

Q: flow rate of discharged air (m^3/s)

C_1: particle concentration of discharged air (pieces/m^3)

C_2: particle concentration of supplied air (pieces/m^3)

Remarks: C_2 may be taken as the average concentration obtained from the values before and after measurement.

(2) The number of separable particles shall be obtained from the following formula:

$$P_i = P_t - P_{Bt}$$

where, P_i: number of particles separable from clean garment (pieces/s)

P_t: apparent total number of particles of objective particle diameter (pieces/s)

P_{Bt}: apparent total number of particles in background (pieces/s)

6.5 Indication of results The number of particles separable from the clean garment shall be written in the form of Table 2, and the summary of the dust generating method shall be shown according to the form of Table 3.

Table 2 Recording form for results of measurement by light scattering automatic particle counter (example)

No.	Name of garment	Measuring position	Measuring place	Temperature (℃)	Humidity (%)	Atmospheric pressure (kPa)	Date of measurement	Measurer
		Whole A part ( )						

Particle diameter division	At background measurement time					At dust generating test time						Number of separable particles pieces/s	
	Flow rate m^3/s	Particle concentration of supplied air pieces/m^3	Particle concentration of discharged air pieces/m^3	Apparent number of particles pieces/s		Flow rate m^3/s	Particle concentration of supplied air pieces/m^3		Particle concentration of discharged air pieces/m^3	Apparent number of particles pieces/s			
0.5 μm min.	1st measurement				Average value	1st measurement	Before test	Average value			Average value		Average value
	2nd measurement					2nd measurement	After test						
						3rd measurement							
1.0 μm min.	1st measurement				Average value	1st measurement	Before test	Average value			Average value		Average value
	2nd measurement					2nd measurement	After test						
						3rd measurement							
5.0 μm min.	1st measurement				Average value	1st measurement	Before test	Average value			Average value		Average value
	2nd measurement					2nd measurement	After test						
						3rd measurement							

Table 3 Summary of dust generating device and method (example)

Summary of measuring system	Name of measuring instrument and summarized specifications
System diagram	
Summary of dust generating method	Summarized explanation of dust generating method
Explanatory diagram	
Explanation of measuring procedure	Explanation of procedures

Errata for JIS (English edition) are printed in *Standardization Journal*, published monthly by the Japanese Standards Association, and also provided to subscribers of JIS (English edition) in *Monthly Information*.

Errata will be provided upon request, please contact:

Standardization Promotion Department, Japanese Standards Association
4-1-24, Akasaka, Minato-ku, Tokyo, 107-8440 JAPAN
TEL. 03-3583-8002 FAX. 03-3583-0462